UNIVERSITY OF SASKATCHEWAN

Department of Computer Science

CMPT 215.3 MIDTERM EXAMINATION

March 2nd, 2005

Total Marks: 50

CLOSED BOOK and CLOSED NOTES
NO CALCULATOR

Time: 50 minutes

Instructions

Read each question carefully and write your answer legibly on the examination paper. **No other paper will be accepted**. You may use the backs of pages for rough work but all final answers must be in the spaces provided. The marks for each question are as indicated. Allocate your time accordingly.

Ensure that your name AND student number are clearly written on the examination paper and that your name is on every page.

Note: a reference table of MIPS instructions is provided at the end of the examination paper.

Question	Marks
1 (6 marks)	
2 (14 marks)	
3 (16 marks)	
4 (14 marks)	
Total	

Name: _____

Student Number: _____

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1. **General** (*6 marks in total – 1 mark for each part*) Give the technical term that best fits each of the following descriptions or definitions.

   (a) Hardware implementations of simple logic functions such as OR and AND.

   (b) A data structure created during the assembly process that stores for each label in a program the memory address to which it corresponds.

   (c) During execution of a program with nested procedure calls, there may be many of these structures on the stack.

   (d) A "law" that quantifies how the system performance improvement that is possible with a given system change is limited by the amount that the changed feature is used.

   (e) A style of instruction set architecture in which arithmetic instructions have no explicit operands.

   (f) An assembly language instruction that has no directly corresponding machine language instruction; an example in MIPS assembly language is "li".

2. **Computer Performance** (*14 marks in total*)

   (a) (*2 marks*) What is the clock period length, in nanoseconds, of a processor with a clock rate of 2.5 GHz? (Recall that a nanosecond is 1.0×10^{-9} seconds.)

   (b) (*2 marks*) List two different types of benchmarks.

(c) (*6 marks*) For each of the following parts, state which ones of the three factors determining CPU execution time (number of machine language instructions executed, clock cycle time, CPI) may change, when the indicated system change is made.

(i) A new compiler is used.

(ii) A different implementation of the same instruction set architecture is used.

(d) (*4 marks*) Consider a system with two types of instructions: type *A* instructions that have a CPI of 1, and type *B* instructions that have a CPI of 2. When a particular program is compiled and run, equal numbers of each type of instruction are executed. Suppose now that through a new compiler optimization, we can reduce the number of type *A* instructions executed to fI_A, for some $f < 1$, where I_A is the original number of type *A* instructions executed.

(i) Give the ratio of the **new** execution time to the **old** execution time of this program, as a function of f.

(ii) Will the MIPS rating for the program increase, or decrease, with this compiler optimization? Explain.

3. **Arithmetic** (*16 marks in total*)

(a) (*2 marks*) Describe how *a*-*b*, where *a* and *b* are 2's complement integers, can be efficiently implemented in an ALU using the adders that implement addition.

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(b) (*6 marks*) Give the representation of -3_{10} in each of the following:

(i) 6 bit 2's complement.

(ii) 6 bit sign-magnitude.

(iii) 6 bit biased notation with bias of 31.

(c) (*4 marks*) Give a logic equation in sum of products form for the following truth table. Simplify your logic equation to the maximum extent possible.

A	B	C	F(A, B, C)
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

(d) (*4 marks*) Recall that in the IEEE 754 floating point standard, single precision floating point numbers have a 1 bit sign field, followed by an 8 bit exponent field (in biased notation with a bias of 127), followed by a 23 bit significand field. What decimal number is represented by 11000000110110000000000000000000?

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4. **Machine and Assembly Language** (*14 marks in total*)

(a) (*2 marks*) Give the two main advantages of requiring that all (non-constant) operands of an arithmetic instruction be registers.

(b) (*2 marks*) Under what circumstances would the outcome of using the MIPS instruction *add* differ from that using the instruction *addu*? Explain.

(c) (2 *marks*) Translate the following MIPS machine language instruction into assembly language: 10001100101001110000000000000100

(d) (*8 marks*) Write a MIPS procedure *swap* that takes as its arguments two addresses of words in memory. If both addresses are non-zero, your procedure should swap the contents of these words and return "0". If either address is zero, your procedure should just return "1" without swapping. You must assume the standard procedure call conventions discussed in class. (You do NOT need to write a main program.)

The End